National Aeronautics and Space Administration

Independent Review for NASA's InfraRed Telescope Facility (IRTF)

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First things first…

Thanks to our SMEs for serving on the IRTF Independent Review panel!

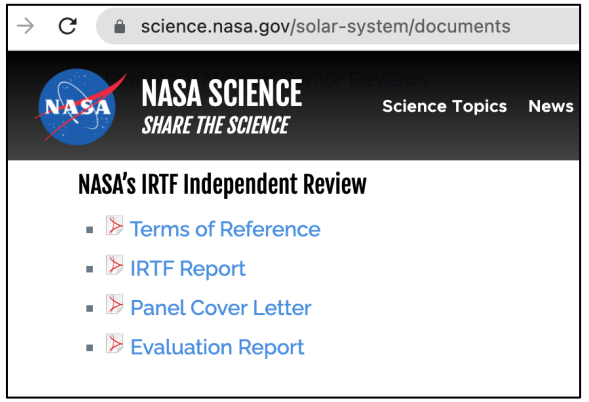
- Nancy Chanover (NMSU; co-chair)
- John O'Meara (WMKO; co-chair)
- Tom Greene (NASA/ARC)
- Stefanie Milam (NASA/GSFC)
- Gerónimo Villanueva (NASA/GSFC)
- Faith Vilas (PSI)

Also, **IRTF** (John Rayner, Bobby Bus, et al.), **PSD** (Kelly Fast, Henry Throop, Amanda Nahm, et al.), **APD staff** (Hashima Hasan, Mario Perez).

NASA's IRTF Independent Review (IR)

- **Objective**:
  - Obtain an independent assessment of NASA's investment in the IRTF
  - Determine if IRTF capabilities are unduplicated with other assets
  - Provide feedback to IRTF management regarding current strategy to achieve Planetary Defense, PSD, and APD Strategic Objectives
- **Logistics**: Six SME panel, two-day in-person review of IRTF report and presentations (incl. visit to facility and Q&A), three core evaluation criteria (see next slide)
- The **IRTF IR is not a periodic review**, and it is not a competition with other NASA missions, projects, or NASA-funded activities. However, PSD might perform these reviews every five years.
- The panel assessment is used by PSD along with other inputs to **balance strategic value** within the broader context of NASA priorities.

Material resulting from the IRTF Independent Review is available at:
www.science.nasa.gov/solar-system/documents



Evaluation Criteria

The SME Panel evaluated a comprehensive IRTF Report against the following metrics:

- **(A) Relevance and responsiveness to NASA strategic goals and objectives**
  - Overall scientific strength and impact of the IRTF in achieving **NASA's strategic goals**.
  - **Productivity** (performance metrics: papers, citations, etc.).
  - Quality of **data archiving and management**.
- **(B) Technical Capability and Cost Reasonableness**
  - An assessment of **technical capabilities**, including the current suite of instrumentation, **to achieve Planetary and Astrophysics Decadal science**.
  - An assessment of **cost reasonableness**, including general budget details and status, yearly operational costs, level of effort, travel costs, Maunakea support services, projected costs for future operation, etc.
- **(C) Management and Operations**
  - An assessment of how IRTF management gets **inputs from the community**, responds to their feedback, and stays competitive.
  - **Facility operations** (e.g., instruments health, carbon footprint compared to other telescopic facilities and plans to be more energy-efficient).
  - Planned **new capabilities and future needs** (2023–2032).

Backup

Planetary Science Division – Use of Telescopes

- PSD flight missions generally send spacecraft to individual targets
- PSD leverages IRTF, ground-based partnerships (e.g., Keck) and space telescopes in SMD's Astrophysics Division, and other ground-based telescopes to support its scientific mission, but does not develop new ground facilities of its own
- PSD also is tasked with planetary defense - to detect, track and characterize any potentially significant impact by a near-Earth object (NEO) – requiring telescopic observations
  - Planetary defense operations often result in small body discoveries important for broader science (e.g., 'Oumuamua) and for identifying spacecraft mission targets

Planetary Science Division – Use of Telescopes

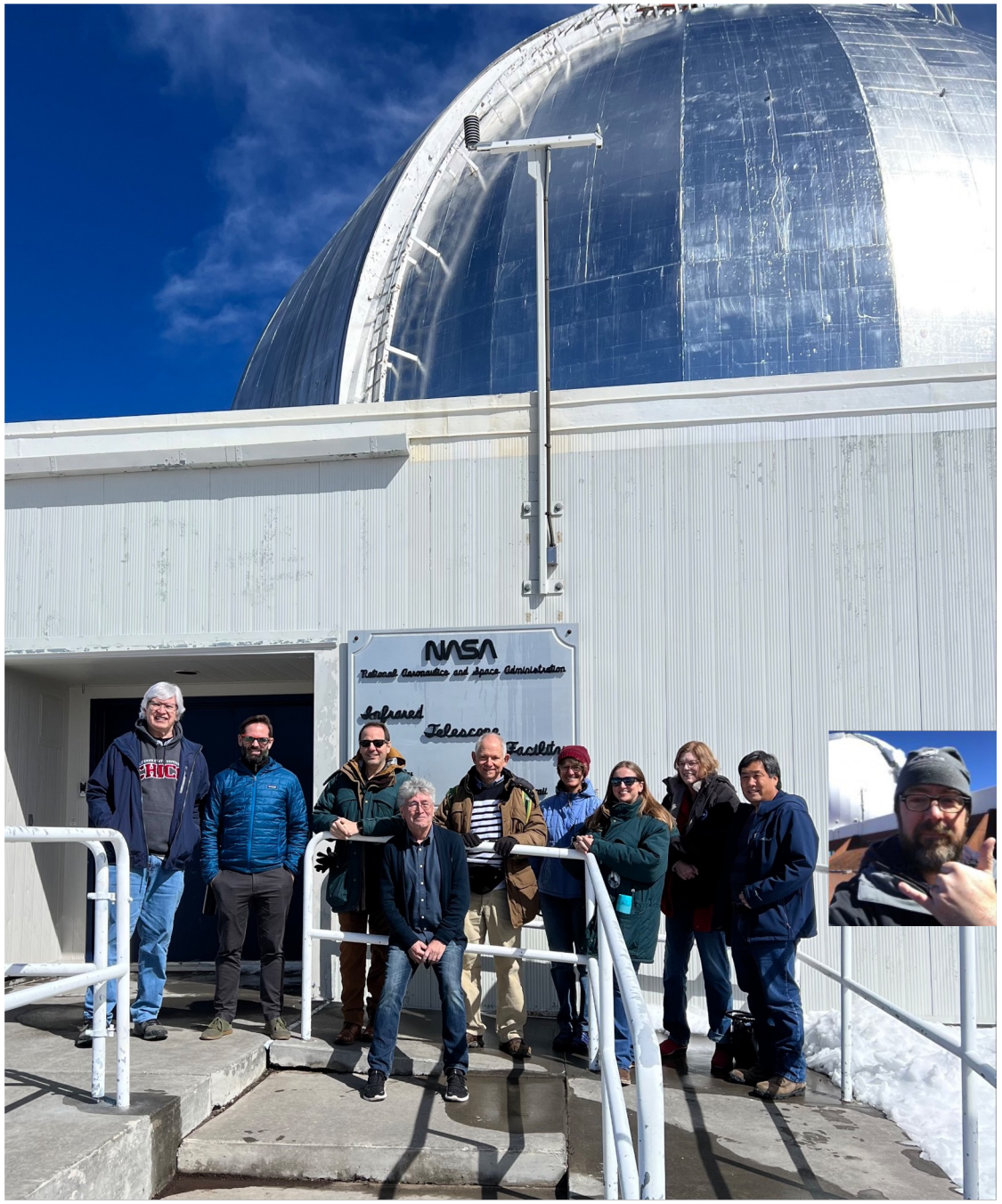
- Find, track, and characterize near-Earth objects (NEOs)
- Discover or determine flight mission targets
- Advise spacecraft design and mission planning
  - Target physical characteristics for informing instrument requirements and spacecraft operations planning
  - Determine spacecraft trajectory
- Achieve spacecraft Level 1s/Mission Success (e.g., DART)
- Enhance or complement spacecraft observations
- Address some elements of Decadal science

IRTF Facility Review Summary

Nancy Chanover, NMSU, Co-Chair
John O‘Meara, W. M. Keck Observatory, Co-Chair

Acknowledgements

- NASA HQ (Lucas Paganini, David Smith, *ex officio* participants)
- NRESS (Julie Luppino, Samica Morrison)
- Panelists
  - Tom Greene (NASA/ARC)
  - Stefanie Milam (NASA/GSFC)
  - Geronimo Villanueva (NASA/GSFC)
  - Faith Vilas (PSI)
- IRTF staff (John Rayner, Bobby Bus)



Uniqueness of IRTF as a NASA facility

The NASA Infrared Telescope Facility (IRTF) represents a unique asset in NASA's portfolio to support NASA's Strategic Objective 1.2 and to provide mission support capabilities and Near-Earth Object (NEO) characterization.

IRTF's unique strengths are derived from a combination of

1. Site: high altitude, low-humidity, stable atmosphere, and geographic location
2. Instrumentation: Only facility in the northern hemisphere with mid-infrared capabilities
3. Operations: Only major facility to perform daylight observations. Very rapid non-sidereal tracking capabilities.

Relevance and responsiveness to NASA strategic goals and objectives

Support of NASA's Objectives

NASA Strategic Objective 1.2: *"Understand the Sun, solar system, and universe"*

- IRTF's infrared observations of objects from small bodies to extragalactic transients directly address Objective 1.2
- Time domain capabilities covering the range of milliseconds (occultations) to decades
- Nearly year-round monitoring capabilities for the solar system due to daytime observing abilities

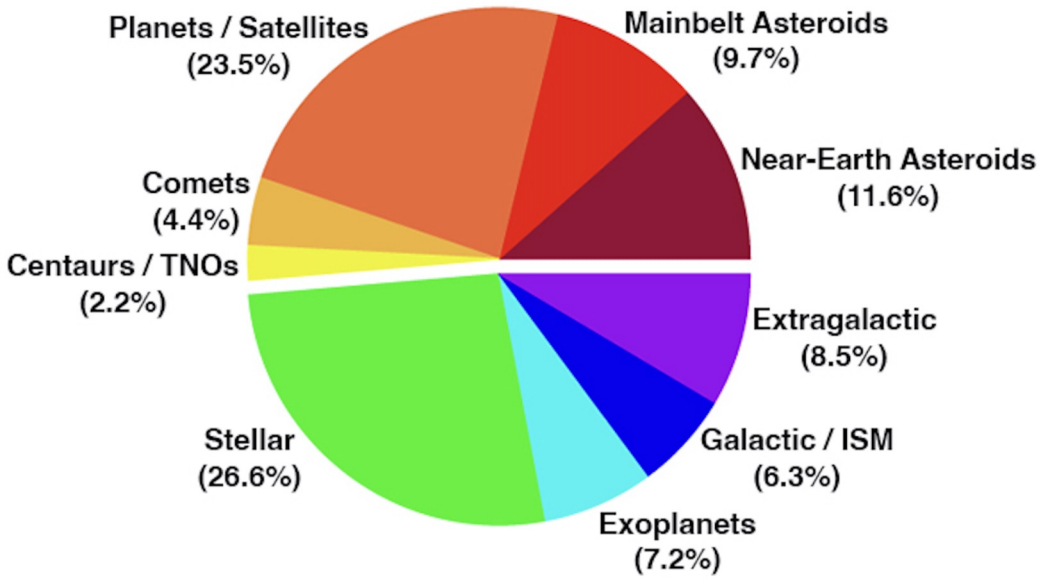
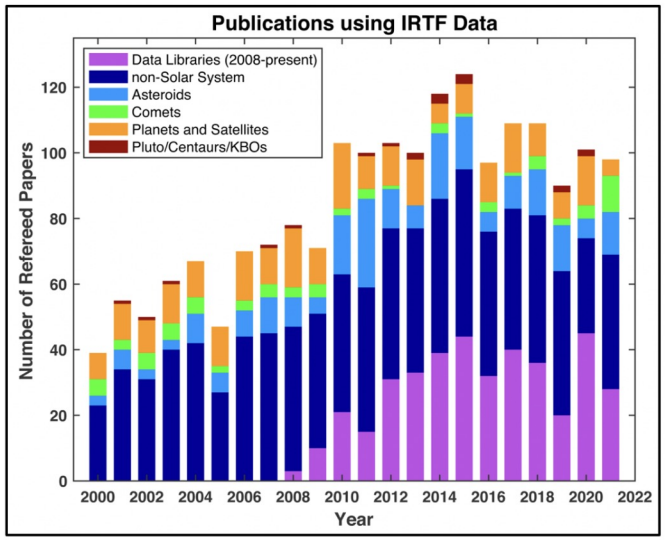


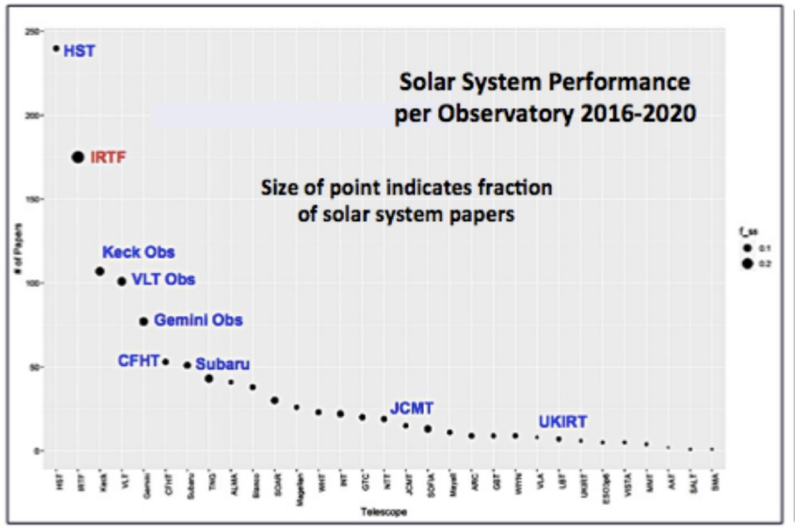
Figure 13. The average distribution of peer-reviewed observing time on IRTF for the past three years, illustrating how IRTF is addressing NASA strategic goals in science.

Scientific Productivity

Scientific productivity in both planetary science and general astrophysics is significant given the aperture size:

- ~100 refereed publications per year
- Publication rate and impact for solar system studies is substantially higher than that of telescopes of its class, and is *higher than all other ground-based telescopes*

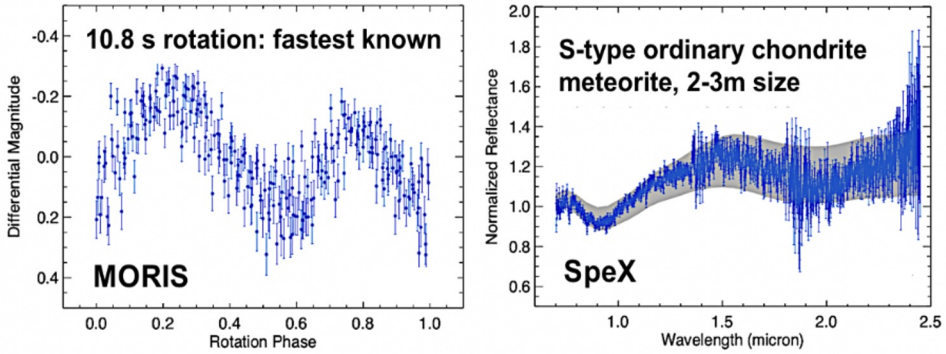




Effectiveness as NEO Characterization Asset

IRTF is uniquely capable for planetary defense

- Efficient visible and near-infrared spectroscopy
- Visible photometry
- Mid-infrared photometry



IRTF observations of 2018 KW1 27 hrs after discovery revealed fast rotation period, substantial mechanical strength

These capabilities combined can provide the determination of bulk density, mass, albedo, and size of NEOs. *No current or planned facility, including NEO Surveyor, combines these capabilities.*

Additionally, IRTF has extremely fast non-sidereal tracking, enabling studies of very close passage, fast-moving objects.

Data Archiving and Management

Data from two main facility instruments, SpeX and iSHELL, are being archived and curated at the IPAC Infrared Science Archive (IRSA), with MIRSI to follow once commissioning is complete.

Python-based data reduction pipeline for SpeX is in development; once complete all legacy SpeX data will be reduced and made publicly available.

The IRTF's current (and planned) data management activities are consistent with NASA requirements and expectations.

Technical Capability and Cost Reasonableness

Technical Capabilities

The conversion of several guest instruments to facility instruments has been a cost-effective way to offer state-of-the-art IR instrumentation at relatively low cost.

Capability	Astro2020 Application	Planetary Application
SpeX (large λ coverage)	Stars (+exoplanet hosts), brown dwarfs, astrophysical transients, planetary atmospheres	organic molecules on outer planets and ISM
iSHELL (high λ resolution)	protoplanetary circumstellar disks, interstellar medium material, exoplanets	characterizing atmospheres of Mars, Uranus, comets, exoplanets
MORIS + MIRSI/MOC		NEOs and planetary defense
Daytime observing	Time-domain phenomena	Venus atmosphere
High speed imaging	occultations	

Technical Capabilities, continued

IRTF has identified a new integral field spectrograph, SPECTRE, covering 0.4-4.2 microns. This instrument has the endorsement of the NIKUG and the IRTF community. SPECTRE would significantly increase IRTF's capabilities across the portfolio.

However, the overall funding plan for the instrument is uncertain, given the challenges in opportunities at NSF, and the need for adequate margin to be incorporated in the cost.

Enhanced Capabilities

Remote observing, daytime observing, short instrument changes and creative scheduling approaches have enabled more versatile usage and high scientific impact.

Director’s Discretionary Time and Target of Opportunity requests are powerful ways to meet the observational needs of time domain astronomers.

Upgrades to image quality have been identified, but have not yet been resourced.

Cost Reasonableness

The science return of the IRTF is high relative to its overall costs (~$6M/yr in 2019).

Additional programmatic value to NASA is added by the significant mission support and planetary defense roles of the IRTF.

IRTF is extremely well managed, providing unique astronomical capabilities at a fraction of the cost of other facilities. Its staff is diverse, specialized and highly trained.

Management and Operations

Community Input

The IRTF Director and staff actively and regularly solicit feedback from the user community through exhibitor booth at conferences, the NASA IRTF-Keck Users Group (NIKUG), and a “Future Directions Workshop” in 2018.

Figure 61. IRTF booth at a recent DPS meeting with IRTF staff taking animated input from a long-time user.

Figure 62. Attendees at the 2018 IRTF Future Directions Workshop help at the Biosphere 2 research facility in Oracle, Arizona.

Facilities Operations

The IRTF has implemented an established approach for identifying, characterizing, and mitigating risks.

The IRTF has reduced its carbon footprint, largely through remote observing and reducing personnel travel.

Multiple programs can (and usually are) executed per night, providing flexibility and efficiency gains.

Strategic Planning

The IRTF identified the completion of SPECTRE as the highest priority for enhancing its role in planetary defense and ability for NEO characterization.

Additional telescope and scheduling improvements (active guiding and better DDT usage, respectively) are also being evaluated.

With the recent completion of Astro2020 and Planetary/Astrobio Decadal Surveys, this is an appropriate time for IRTF to reignite its strategic planning efforts.

Contribution to Maunakea Observatory's Efforts

IRTF has no budget for outreach, and no requirements to participate in Maunakea Observatory (MKO) efforts. Nevertheless, IRTF participates in

- K-12 STEM outreach
- Maunakea Scholars program
- UH undergraduate training, NSF REU program

Areas for Improvement

SPECTRE funding: The budget to construct SPECTRE is currently uncertain, with estimates in the range of $3-4M, without margin. Proposals at this scale for NSF funding have difficulty succeeding in the current environment. Moreover, instrumentation like SPECTRE may need on the order of 30% margin in cost estimate.

Optical improvements: A number of optical improvements, including adaptive optics, have been identified by the community, but cannot be realized within the current budget.

Target of Opportunity (ToO) vs DDT: At present, the community is using DDT requests to fulfill the role of ToO more often than the existing ToO TAC-approved process. Policy clarity on ToO vs DDT is warranted

Data management: Automatic data reduction to Level 1 data products is not yet in place. Progress is currently limited to external (e.g. ADAP-funded) efforts. A timeline to establish a full archive of IRTF data is not yet developed.

Areas for Improvement

Strategic planning: IRTF does not have a focused strategic planning document covering the next decade, with the last major strategic exercise in 2018. Long-term alignment with Decadal future priorities is not sufficiently explored.

Staff: Key staff retirements in the near future may need additional effort and focus.

Community engagement beyond STEM: The nature of community engagement in Hawai'i is evolving beyond a purely STEM focus. Robust community engagement will be needed in the coming years, but outreach efforts at IRTF are not in the budget

MKSOA: Management of Maunakea transitions to the Mauna Kea Stewardship and Oversight Authority (MKSOA) in 2028, with sublease expiration for UH/IRTF in 2033. Engagement should begin early and robustly if IRTF is to continue operations after 2033. Co-Chair O'Meara will brief SMD leadership on Maunakea issues separately, as this is not in the charge of the review.